THE BIOLOGY AND ECOLOGY OF LAKE VICTORIA FISHES:

THEIR DEVELOPMENT AND MANAGEMENT

(UGANDAN VERSION)

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December 2000

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CHAPTER 9

Trophic Interrelationships and Food-Webs among the Fishes in Ecosystems of the Victoria and Kyoga Lake Basin.

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Abstact

The Victoria and Kyoga lake basins had a high fish species diversity with many fish species that were found only in these lakes. Two Tilapiines species *Oreochromis esculentus* and *Oreochromis variabilis* were the most important commercial species in these lakes and were found nowhere else on earth except in the Victoria and Kyoga lake basins (Graham 1929, Worthington 1929). Lakes Kyoga and Nabugabo also had endemic haplochromine species (Worthington 1929, Trewavas 1933, Greenwood 1965, 1966). As stocks of introduced species increased, stocks of most of the native species declined rapidly or disappeared altogether. The study was carried out on Lakes Victoria and Kyoga, River Nile, some selected satellite lakes from the two basins namely Lakes Mburo, Kachera, Wamala, Kayanja, Kayugi, Nabugabo, Victoria, Victoria nile and River Sio(Victoria lake basin). Lakes Kyoga (Iyingo), Nawampasa, Nakuwa, Gigati, Nyaguo, Agu, Kawi and Lemwa (Kyoga lake basin).

Species composillon and relative abundance of fishes were estimated by detennining the overall average total number of each species encountered. A trophic consists of species using the same food category. Shannon-Weaver Index of diversity H' (Pielou, 1969) and number of trophic groups, were used to estimate the Trophic diversity of various fish species in the lakes. Food analysis has been done on some fishes in some of the sampled lakes and is still going on, on remaining fishes and in some lakes.

Generally fish ingested detritus, *Spirulina, Melosira,* filamentous algae, *Planktolyngbya, Microcysists, Anabaena, Merismopedia, Spirogyra,* higher plant material, rotifers, Ostracodes, Chironomid larvae and pupae, Choaborus larvae, *Odonata, Povilla,* Insect remains, *Caridina,* fish eggs and fish. Eight trophic groups were identified from thes food items ingestes. These included detritivores, algae eaters, higher plant eaters, zooplanktivores, insectivores, molluscivores, prawn eaters, paedophages and piscivores.
Trophic diversity by number of trophic groups was highest in Lake Kyoga (6) followed by lakes Kayugi, Nabugabo, River Nile and Mburo (3) and the lowest number was recorded in kachera (2).

Back ground

The Victoria and Kyoga lake basins had a high fish species diversity with many fish species that were found only in these lakes. Two Tilapiines species *Oreochromis esculentus* and *Oreochromis variabilis* were the most important commercial species in these lakes and were found nowhere else on earth except in the Victoria and Kyoga lake basins (Graham 1929, Worthington 1929). Many other species, such as *Protopterus aethiopicus, Bagrus docmac, Clarias gariepinus, Barbus spp,* monnyrids, *Synodontis* spp, *Schilbe intermedius* and

Rastrineobola argentea, were also abundant (Graham 1929, Worthington 1929, 1932a, Kudhongania & Cordone 1974). The rivers of the Victoria lake basin had a number of riverine species the most commercially important of which were *Labeo victorianus* and *Barbus altianalis*. Lake Victoria contained over 300 species belonging to one group the haplochromine cichlids over 99% of which were endemic (Witte et al. 1992 a, b). Lakes Kyoga and Nabugabo also had endemic haplochromine species (Worthington 1929, Trewavas 1933, Greenwood 1965, 1966). The fishes occupied virtually all trophic levels and played an important role in the flow of organic matter and overall ecological efficiency of these lakes. The fishes were important as human food and provided outstanding opportunities for studying evolutionary processes and community ecology (Lowe- Mc Connell, 1987).

By the 1960's, stocks of the native tilapiines and other large species of Lake Victoria had been reduced by overfishing (Jackson 1971, Ogutu-Ohwayo 1990a). Nile perch and four tilapiine species were introduced into many of the lakes in the basin, including lakes Victoria and Kyoga in 1950's and early 1960's to improve stocks of the declining fishery. As stocks of introduced species increased, stocks of most of the native species declined rapidly or disappeared altogether. Of the more than 300 native species, only *Rastrineobola argentea* (Mukene) remained abundant (Ogutu-Ohwayo 1990c). Haplochromines dropped from about 80% of the fish biomass in Lake Victoria in 1970s to less than 1% in 1980s, and about 200 species are feared to have become extinct. These haplochromines were important as food and were of medical, scientific and ecological value. They occupied all trophic levels and played a major role in the flow of energy in the ecosystem. They were crucial in maintaining the ecosystem that supported other food fishes, as well as the high biodiversity associated with the lake basin. Studies of haplochrornines played a major role in illustrating how organisms undergo adaptive radiation to produce new species, and how a trophically diverse assemblage can efficiently utilize an ecosystem.

As a result of overfishing and introduction of exotic fishes, populations of most of the native species declined and many species became extinct (Witte et al. 1992 a, b). The original decline in fish stocks was due to overfishing (Jackson 1971, Ogutu - Ohwayo 1990 a) but the recent and more drastic decline has been due to predation by the introduced Nile perch and overall environmental degradation (Ogari & Dadzie 1988, Ligtvoet & Mkurnbo 1990, Ogutu - Ohwayo 1990 b, Witte et al. 1992 a, b).

The loss of species and trophic diversity, and associated alterations in food webs have been accompanied by more frequent algal blooms and deoxygenation of the hypolimnion, which sometimes have been associated with mass fish kills in Lake Victoria (Ochumba & Kibara 1989). The accumulation of the excess organic matter is an indication that much of the organic matter produced in the lake is not being channelled efficiently through the food web. The native fishes had occupied virtually all trophic levels, including phytoplanktivores, zooplanktivores, insectivores, molluscivores, detritivores, piscivores and maintained an efficient flow of organic matter in the system. The depletion in stocks of this trophically diverse fish community by Nile perch changed the food web of the lake and seems to have reduced grazing pressure and the overall ecological efficiency of the ecosystem in the lakes.

Study Objectives

The overall objective of this study was to rectify the serious lack of knowledge on trophic ecology in the Victoria and Kyoga lake basins. This was achieved by specifically examining, species composition of fishes, the food and trophic diversity of fishes in the different lakes in the Victoria and Kyoga lake basins and how this compares between lakes and with lakes Victoria and Kyoga.

Study Area, Materials and Methods

Study Area

The study was carried out on Lakes Victoria and Kyoga, River Nile, some selected satellite lakes from the two basins namely Lakes Mburo, Kachera, Wamala, Kayanja, Kayugi, Nabugabo, Victoria, Victoria nile and River Sio(Victoria lake basin). Lakes Kyoga (Iyingo), Nawampasa, Nakuwa, Gigati, Nyaguo, Agu, Kawi and Lemwa (Kyoga lake basin). Figs

Materials and Methods

Fish were collected using experimental gill nets, locally constructed basket traps sometimes from commercial catches. Three fleets of gill nets were set at one selected station at various distances from the shore line to the open water on every small lake and some three or four selected stations on the bigger lakes. On retrieval fish were sorted into their taxonomic groups to species level whenever possible and the number and weight of each taxa recorded. The bigger fishes were cut open, their stomachs dissected out and their degree of fullness determined as I(full), 3/4, I/2, I/4, <1/4 or 0 (empty). The stomachs were labelled and preserved for later laboratory analysis. The fishes not identified in the field especially haplochromines were preserved in 10% formaldehyde solution, labelled with date and habitat of capture and transported to Fisheries Research Institute (FIRI) laboratory where further identifications and food analysis were done.

In the laboratory fishes not identified in the field were sorted into taxonomic groups to genus or species level where possible. If a fish could not exactly fit the described characters it was assigned a "chieronym". Morphological characteristics of small fishes were examined with the help of a binocular microscope. The species that were not identified in the laboratory were compared with specimens of described species present in FIRI museum.
The preserved fishes were treated as follows: -
The fish were cut open, the stomach of each fish dissected out and its degree of fullness determined. Both the preserved stomachs and those got from the preserved fish were slit open and the contents emptied on to a petri dish, flooded with water and examined first under a binocular microscope and later on a slide under a compound microscope. The food items were sorted and identified as far as possible and estimated as percentage through judgement by eye. The percentages were then allotted points 0, I, 2, 4, 8 and 16 depending on the relative importance of the food item in the stomach according to Hynes (1950).

Species composItion and relative abundance of fishes were estimated by determining the overall average total number of each species encountered. The percentage contribution by number of each species were calculated by dividing the total number of each species by the total number of all the species, multiplied by 100. The data were presented in tabular form. The food items were classified into related groups and the dominant food category was taken as decisive of the Trophic classification (Witte, 1981). A trophic consists of species using the same food category. Shannon-Weaver Index of diversity H' (pielou, 1969) and number of trophic groups, were used to estimate the Trophic diversity of various fish species in the lakes.

Results

Food analysis has been done on some fishes in some of the sampled lakes and is still going on, on remaining fishes and in some lakes.

Mburo

Overall nine fish species, five non-haplochromines and four haplochromines were encountered in Lake Mburo. The non-haplochromines included *Oreoehromis eseulentus*, *Oreoehromis niloticus*, *Oreoehromis leueostietus*, *Clarias gariepinus* and *Protopterus aethiopicus*. The haplochromines included *Harpagoehromis squamipinus*, *Astatotilapia nubila*, *Astatotilapia aeneoeolor*, and *Astatoreehromis aUuaudii*. Out of these species only four non haplochromine species have been examined and contained food contents. These included 0. *leueostietus*, C. *gariepinus*,*O. niloticus* and *P. aethiopieus* (Fig. 3).

Kachera

Overall twelve fish species, seven non-haplochromines and four haplochromines were encountered in Lake Kachera. The non-haplochromines included *Oreoehromis esculentus*, *Oreoehromis leueostietus*, *Oreoehromis nilotieus*, *Protopterus aethiopicus*, *Clarias gariepinus*, *Clarias lioeephalus* and *Tilapia zillii*. The haplochromines included *Harpagoehromis squamipinus*, *Astatotilapia nubila*, *Astatotilapia* spp and *Astatoreehromis aUuaudii*. Out of these species only four non haplochromine species have been examined and contained food contents. These included O. *leueostietus*, O. *esculentus*, C. *gariepinus* and O. *niloticus* (Fig. 4).

Kayugi

Overall eleven fish species, six non-haplochromines and five haplochromines were encountered in Lake Kayugi. The non-haplochromines included *Brycinus sadleri*, *Barbus kersterni*, *Gnathonemus vietoriae*, *Oreoehromis esculentus*, *Petroeephalus eatastoma*, and *Protopterus aethiopicus*. The haplochromines included *Astatotilapia velifer*, *Astatotilapia nubila*, *Gaurochromis simpsoni*, *Astatoreehromis aUuaudii* and *Prognathoehromis venator*. Out of these species only five non haplochromine species have been examined and contained food contents. These included O. *esculentus*, O. *leueostietus*, G. *vietoriae*, C. *gariepinus*, and *P. aethiopicus* (Fig. 5).

Nabugabo

Overall sixteen fish species, twelve non-haplochromines and four haplochromines were encountered in Lake Nabugabo. The non-haplochromines included *Brycinus sadleri, Barbus kersterni, Gnathonemus longibarbis, L. niloticus, Mercusenius grahami,* 0. *rendalli,* 0. *leucostictus,* 0. *niloticus, P. aethiopicus, Schilbe intermedius, Synodontis afrofischeri* and *T. zillii.* The haplochromines included *Astatotilapia velifer, Astatotilapia nubila, Gaurochromis simpsoni, Astatorechromis alluaudii* and *Prognathochromis venator.* Out of these species only seven non haplochromine species have been examined and contained food contents. These included 0. *esculentus,* 0. *leucostictus,* G. *victoriae,* C. *gariepinus* and *P. aethiopicus* (Fig. 6).

Victoria **Nile**

Overall six non-haplochromines and some haplochromines were encountered in Victoria Nile. The non-haplochromines *included M kannume, L. niloticus, B. altianalis,* 0. *niloticus* and *T. Zillii.* Out of these species only three non haplochromine species have been examined and contained food contents. These included *L. niloticus,* O. *niloticus* and *M kannume* (Fig. 7).

River Sio

Overall fourteen non-haplochromines and one genus of haplochromines were encountered in Victoria Nile. The non-haplochromines included *M Grahami, Barbus jacksonii, B. Sadleri,* S. *Victoriae, L. niloticus,* S. *afrofischeri, Brycinus jacksonii,* C. *gariepinus,* S. *intermedius,* 0. *Leucostictus,* O. *niloticus, L. victorianus* and G. *Longbarbis.* The haplochromines encountered were of *Ptyochromis spp.* None of these species has been examined for food.

Kyoga

Overall thirty two fish species, eighteen non-haplochromines and fourteen haplochromines were encountered in Lake Kyoga. The non-haplochromines included *L. niloticus, Brycinus sadleri, Gnathonemus victoriae,* 0. *niloticus,* S. *victoriae, Synodontis afrofischeri, Mormyrus macrocephalus, T. zillii,* 0. *leucostictus, Schilbe intermedius, P. aethiopicus, Clarias gariepinus, Labeo victorianus,* G. *longibarbis, B. altianalis, P. catastoma* and *Mormyrus kannume.* The haplochromines included *Paralabidochromis "blackpara", Astatotilapia nubila, Pssamochromis "shovelmouth", Astatotilapia "kyogaastato", Xystichromis "flameback", Paralabidochromis "earthquake", Prognathochromis guiarti, Yssichromis kyogazooplanktivore, Xystichromis phytophagus, A. alluaudi, Lipochromis parvidens, Lipochromis "blackcryptodon", Haplochromis lividus* and *Gaurochromis* spp. Out of these species only six non haplochromine species and eight haplochromine species have been examined and contained food contents. These included *L. niloticus, B. altianalis, Mercusenius grahami, P. aethiopicus,* S. *victoriae and* S. *intermedius.* (Fig. 8). The haplochromines included *P. "blackpara", A. nubila, P. "shovelmouth", A. "kyogaastato", X "flameback", P. "earthquake", Y kyogazooplanktivore, X phytophagus* and *A. alluaudi.*

So far results obtained indicate that generally fish ingested detritus, *Spirulina*, *Melosira*, filamentous algae, *Planktolyngbya*, *Microcysists*, *Anabaena*, *Merismopedia*, *Spirogyra*, higher plant material, rotifers, Ostracodes, Chironomid larvae and pupae, Choaborus larvae, *Odonata*, *Povilla*, Insect remains, *Caridina*, fish eggs and fish. These food items were grouped into 8 categories for purposes of trophic classification. These included detritus, algae, higher plant material, zooplankton, insects, molluscs, prawns, fish eggs and fish. The percentage contribution of food categories in diet of different fishes in different lakes (Figs 3, 4, 5, 6, 7, 8 and 9.

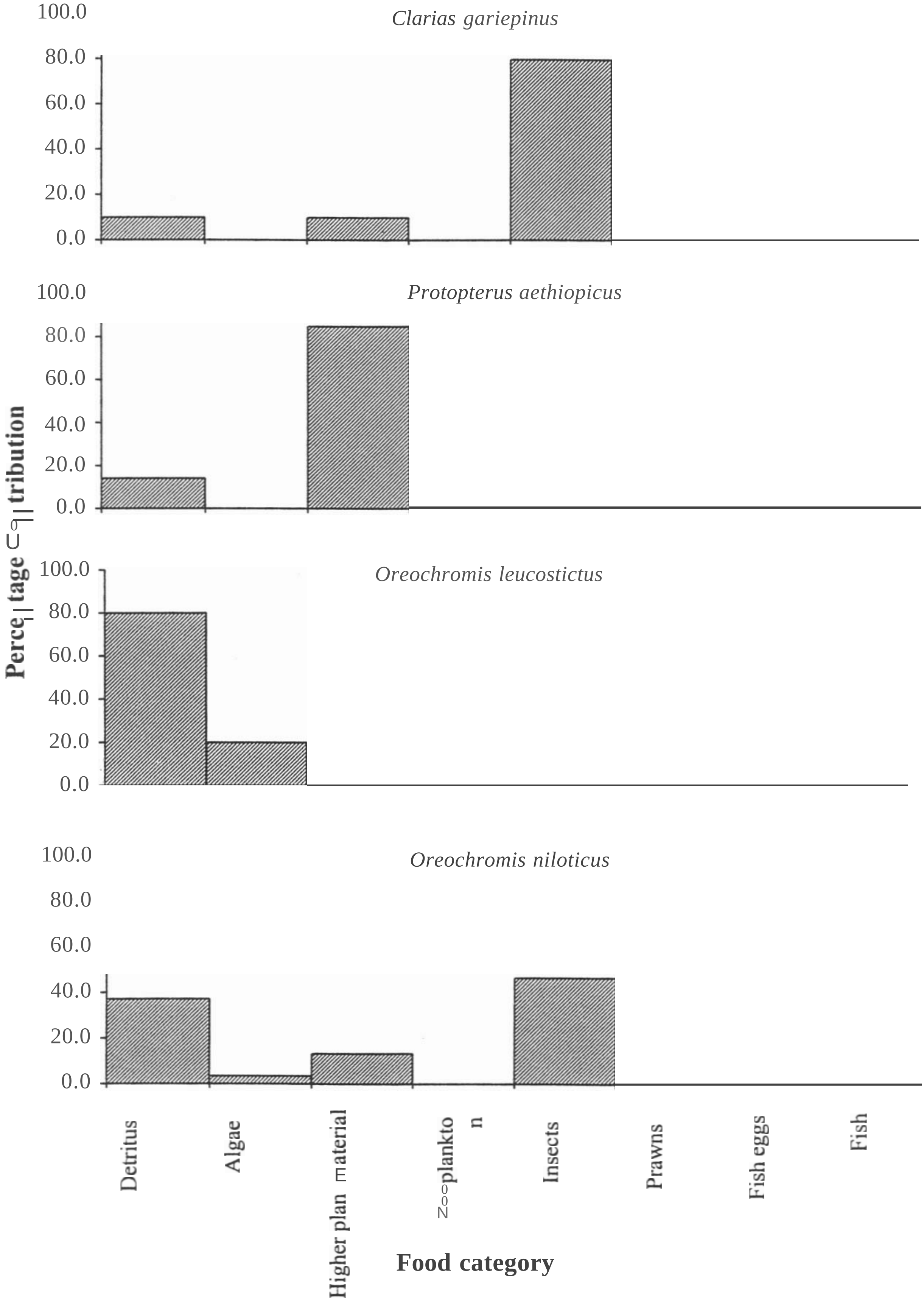

Fig. 3 **Percentage contribution of food category by points to the diet of the different fishes from Lake Mburo**

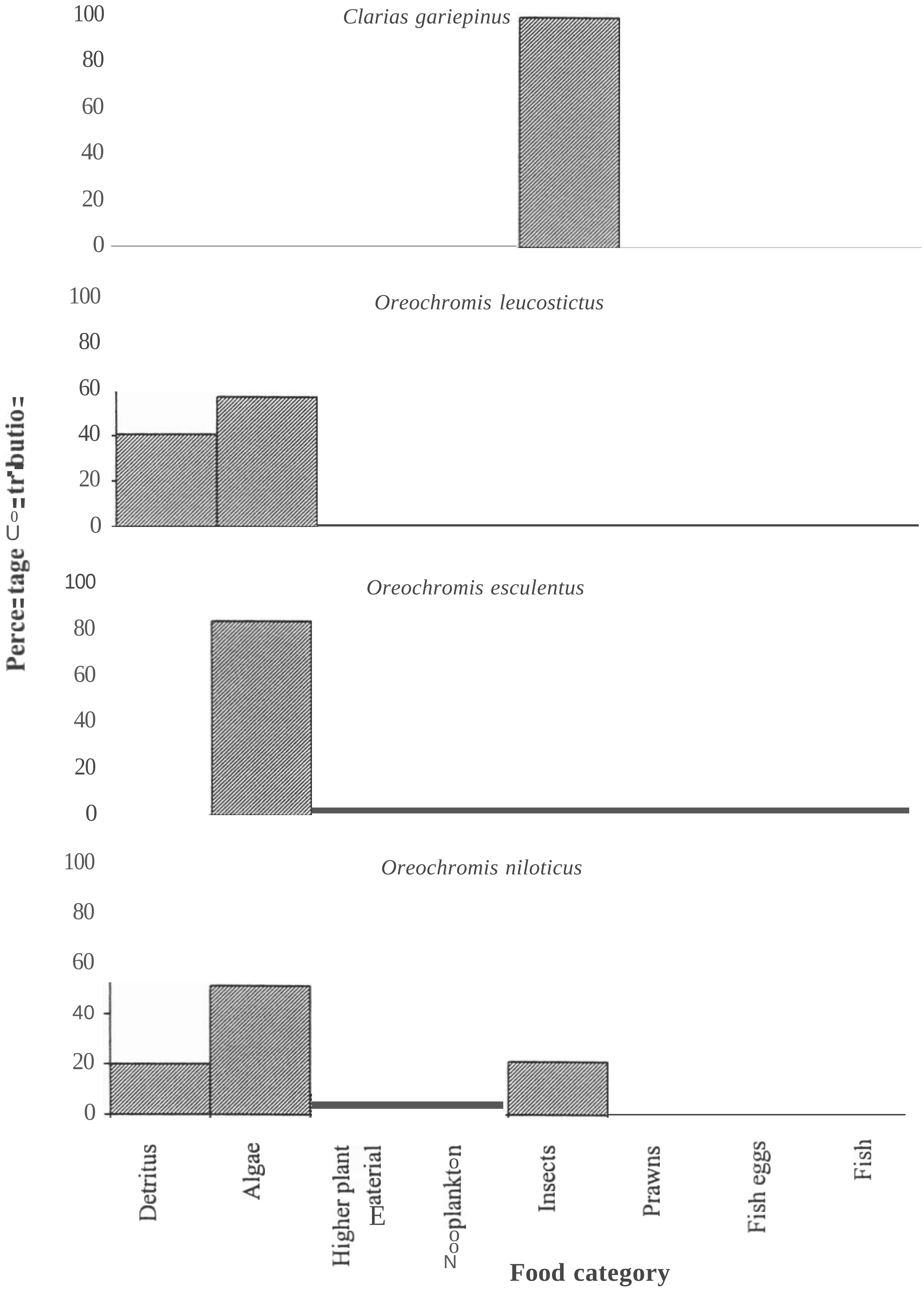

Fig. 4 **Percentage contribution of food category by points to the diet of the different fishes from Lake Kachera**

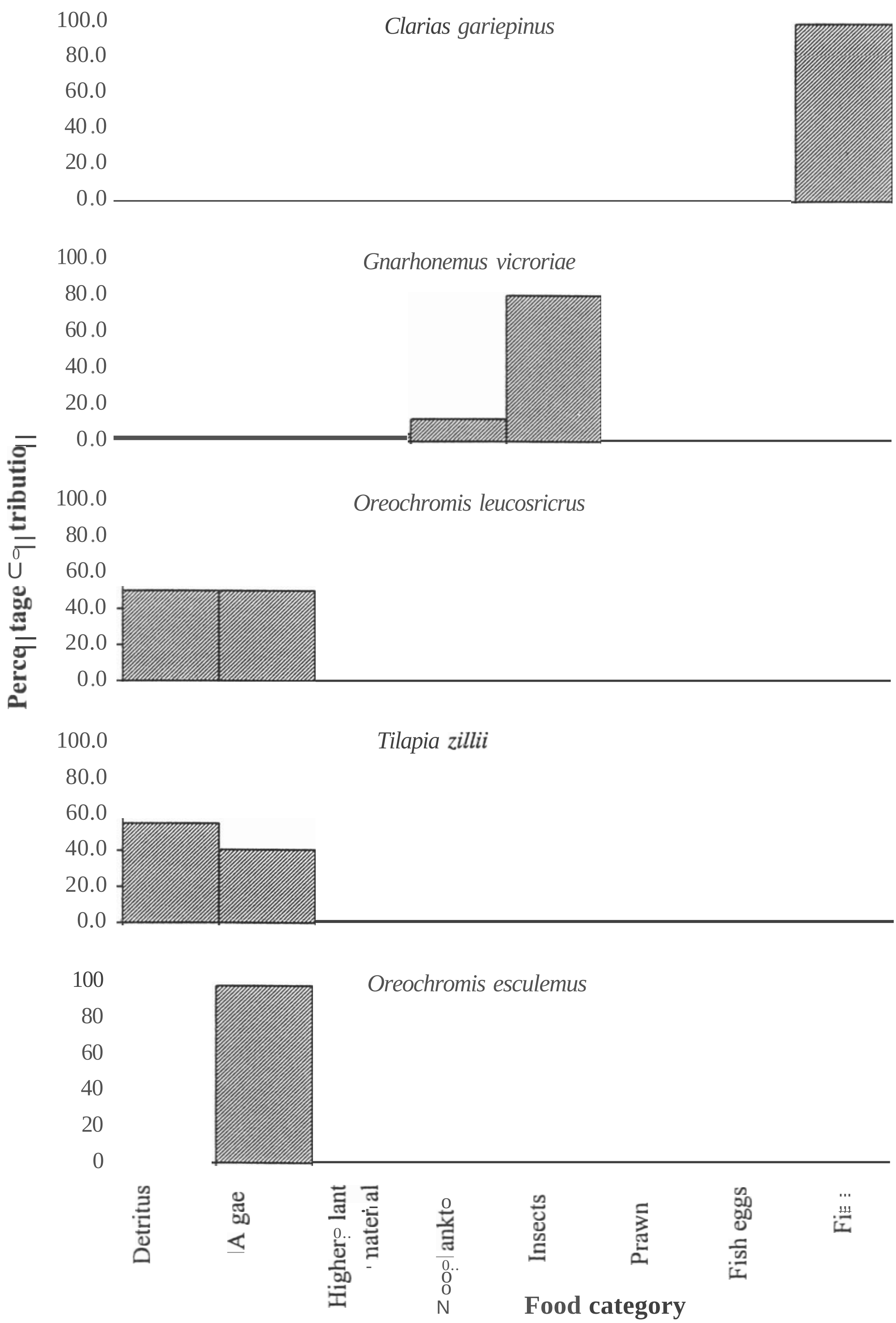

Fig 5 Percentage contribution of food category by points to the diet of the different fishes from Lake Kayugi

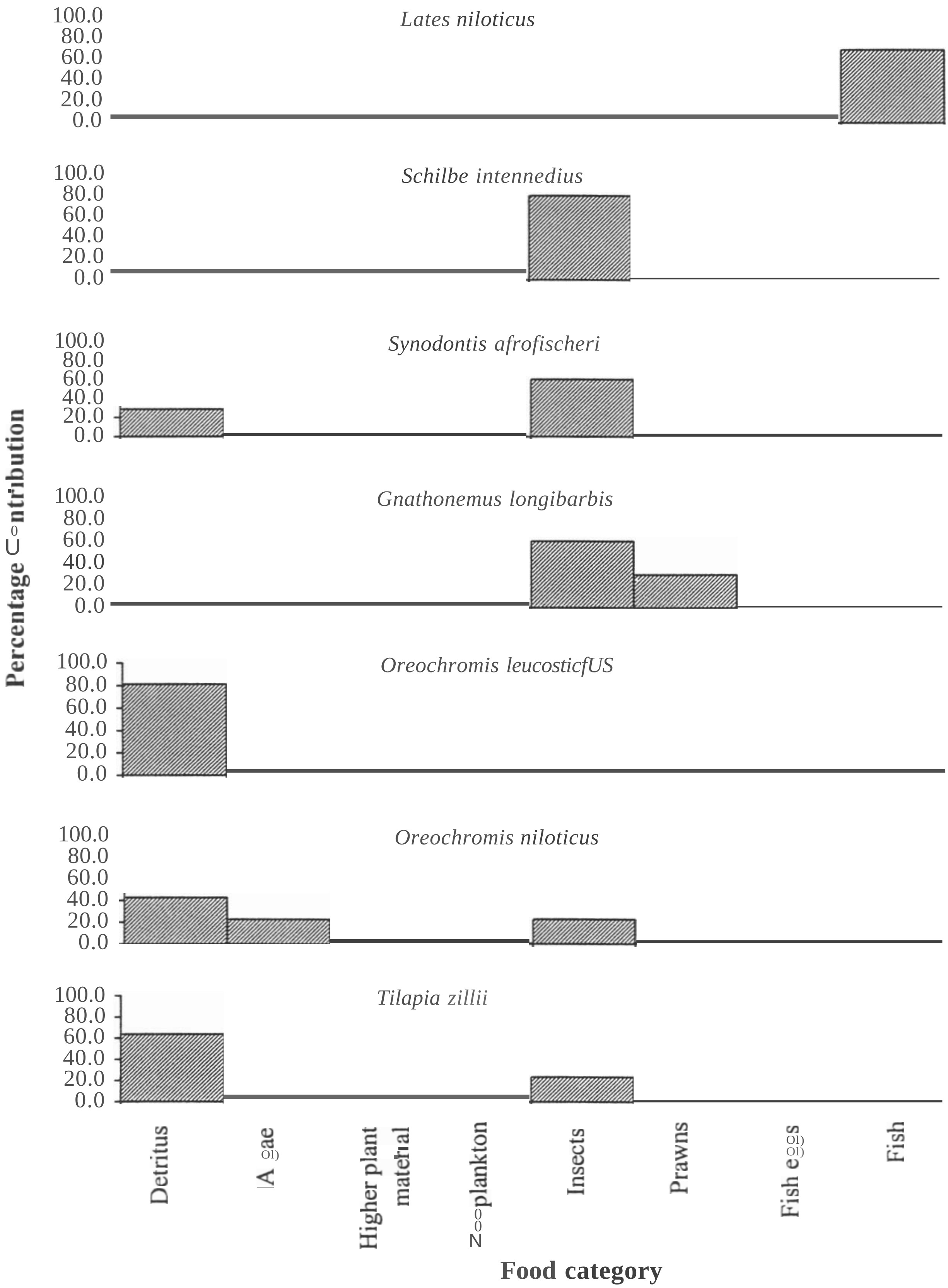

Fig. 6 **Percentage contribution of food category by points to the diet of the different fishes from Lake Nabugabo**

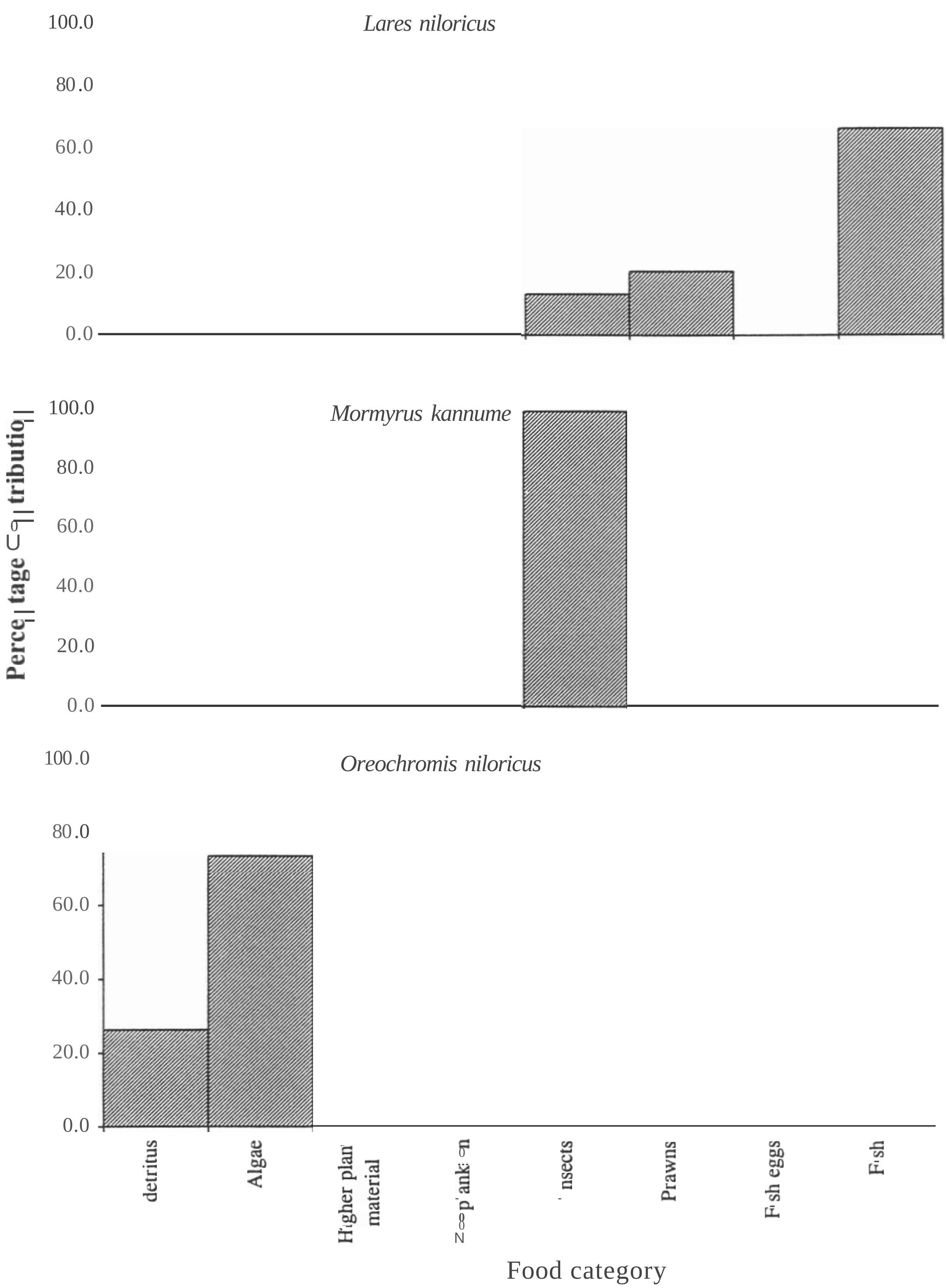

Fig 7 Percentage contribution of food category by points to the diet of the different fishes from Victoria Nile

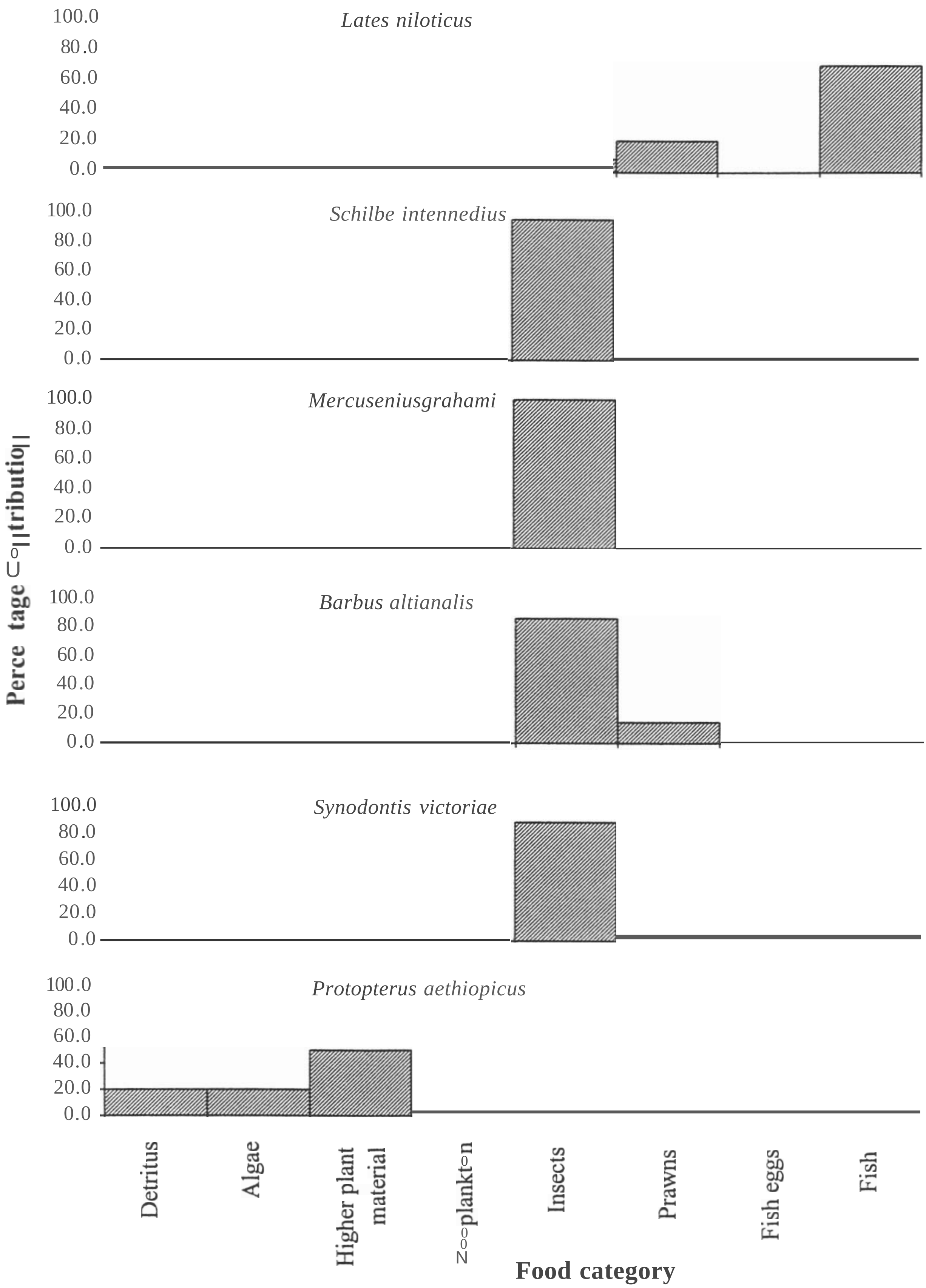

Fig. 8 Percentage contribution of food category by points to the diet of the different fishes from Lake Kyoga

Trophic diversity by number of trophic groups varied between lakes. Lake Kyoga (6) had the highest followed by lakes Kayugi, Nabugabo, River Nile and Mburo (3) and the lowest number was recorded in kachera (2) (Fig 9).

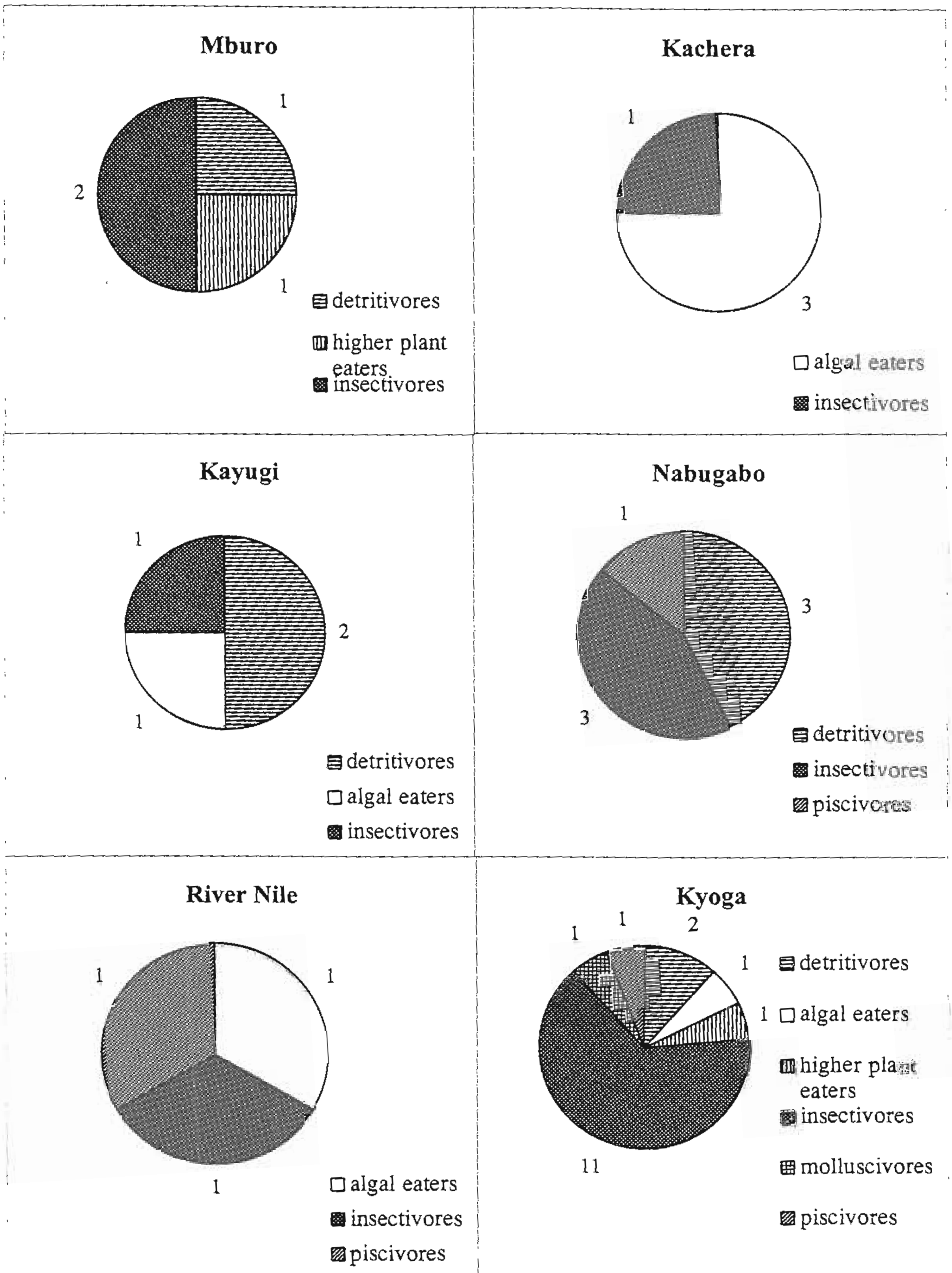

Fig 9 Comparison of trophic diversity by number of trophic groups between lakes

References

Graham, M. 1929. The Victoria Nyanza and its fisheries. A report of the survey of Lake Victoria 1927-1928 and Appendices. Crown Agents for colonies. 225pp.

Greenwood, P.H. 1965. The cichlid fishes of Lake Nabugabo, Uganda. *Bulletin of the British Museum of Natural History (Zoology)* 12(9): 313-357.

Greenwood, P.H. 1966. The fishes of Uganda. The Uganda society, Kampala. (2nd edition)

Hynes, H.B.N. 1950. The food of the freshwater sticklebacks *(Gasterosteus escleatus* and *Pygosteus pungitius)* with a review of methods used in the food of fishes. *J Anim. Ecof.* 19: 36-58.

Jackson, P.B.N., 1971. The African Great Lakes fisheries: past, present and future. *Afr. J Trap. Hydrobiof. Fish.* I: 45-54.

Ligtvoet, W. & O.C. Mkumbo 1990. Effects of changes in fish populations in Lake Victoria on the food of otters in *(Lutra maculicollis* Schinz and *Aonyx capensis* Lichtenstein). *Afr. J Ecol. 28:322-329.*

Kudhongania, A.W & A.J. Cordone 1974. Batho-spatial distribution pattern and biomass estimate of the major demersal fishes in Lake Victoria. *Afr. J trop.Hydrobiof. Fish. 3:15-31.*

Ligtvoet, W. & O.C. Mkurnbo 1990. Stock assessment of Nile perch in Lake Victoria. FAO Fish. Rep., no.430. pp.35-74.

Lowe- Mc Connell, R.H. 1987. Ecological studies in tropical fish communities. University Press, Cambridge. 76pp.

Ochumba, P.B.O. & D.1. Kibara 1989. Observations on blue green algal blooms in open waters of lake Victoria, Kenya. African Journal of Ecology 27: 23-34. *Neth.J.Zool.3l: 149-174.*

Ogari, J. & S. Dadzie 1988. The food of the Nile perch, *Laces niloticus* (L.) after disappearance of the haplochromine cichlids in the Nyanza Gulf of Lake Victoria (Kenya). *J Fish. Bioi.,* 32:571-577.

Ogutu-Ohwayo, R. 1990a. The decline of the native fishes of Lakes Victoria and Kyoga (East Africa) and the impact of introduced species, especially the Nile perch, *Lates niloticus* and the Nile tilapia, *Oreochromis niloticus.* Environmental Biology and Fisheries, 27: 31- 96.

Ogutu-Ohwayo, R. 1990c. The reduction in fish species in Lakes Victoria and Kyoga (East Africa) following hurnan exploitation and introduction of non-native fishes. *J. Fish. Bioi., 37* (SuppI.A),207-8.

Ogutu-Ohwayo, R. & R.E. Hecky 1991. Fish introductions in Africa and some of their implications. *Can. J Fish. Aquat. Sci* 48 (Suppl. I): 8-12.

Trewavas, E., 1933. Scientific results of Cambridge expedition to the East African lakes, 1930. 1-11. The cichlid fishes. *J Linn. Soc. Land. 38:309-341.*

Witte, F.,T.Goldschmidt, K.Goudswaard, W. Ligtvoet, M.J.P. Oijen & J.H. Wanink. I992a. Species extinction and concomitant ecological changes in LakeVictoria. *Neth. J Zool. 42:214-232.*

Witte, F., Goldschmidt, K.Goudswaard, W. Ligtvoet, M.J.P. Oijen & J.H.Wanik 1992b. The destruction of an endemic species flock: quantitative data on the decline of haplochromine cichlids of Lake Victoria. *Env. Bioi. Fish.* 34: 1-28.

Worthington, E.B. 1929. A report on the fishing survey oflakes Albert and Kyoga. Crown Agents for the colonies. London. 136 pp.

Worthington, E.B. 1932. A report on the fisheries of Uganda. Crown Agents for the colonies. London. 95pp.